

AUSTRALIAN FRESHWATER POLYZOA. PART I.

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(Plate xlvii.)

The present paper deals with an account of the known freshwater Polyzoa of Australasia, and a description of a new species of *Fredericella*.

Practically nothing has been attempted in connection with this portion of our freshwater fauna since the work of Macgillivray, Whitelegge, and Hamilton, which was done at least twenty years ago.

An examination of Whitelegge's "Invertebrate Fauna of Port Jackson and Neighbourhood" shows that among the seven members of the *Phylactolamata* which he collected, there was no species which he could then refer to known forms except *Plumatella Aplinii* and *Lophopus Lendenfeldi*, both of which were confined to Australia. Since then we have found the common European species, *Plumatella repens*, in abundance in Queensland, New South Wales, and South Australia; also in New Zealand; and *Paludicella ehrenbergii* in New Zealand.

Whitelegge records a species of *Fredericella* which he remarks on as being closely allied to *F. sultana*, but differing from it in the shape of the statoblasts, which are "nearly round and not bean-shaped." Beyond this record there is no published mention of *Fredericella* from Australia, except in the "Cambridge Natural History," this latter mention being, no doubt, due to Whitelegge's record. This species has been found in abundance since in New South Wales, especially in connection with our water-supply,

where it causes the same trouble as in the water-mains of other countries. For the material which I have been privileged to examine, I am indebted to Dr. Stokes.

Mr. — Bradley, of Adelaide, who has spent some time in collecting and examining the freshwater forms of South Australia, informs me that *Plumatella repens* and *Fredericella sultana* are abundantly represented in that State; but I have no doubt that the latter species is wrongly named, and is none other than the species, originally found by Whitelegge, which certainly bears a very close resemblance to *F. sultana*, and might readily be confused as a mere variety of that form. However, considering that it differs from *F. sultana* in the shape of the statoblasts and the number of the tentacles, in no small measure it seems worthy of a new specific name.

Dendy has also recorded *Fredericella sultana*(?) from New Zealand.

Species of *Plumatella* occur in New South Wales, which, judging from the character of the statoblasts, differ from any known species. It is deemed advisable, however, to refrain from creating species on this information, until one has had the opportunity of examining the whole colony, especially so as this particular genus offers great difficulties in connection with the making of good species, inasmuch as variation takes place to such an extent that it would appear that many so-called species are no doubt mere varieties.

Mr. A. McCulloch, of the Australian Museum, found in the Nepean River, a mass of Polyzoa growing on a submerged stick; and, judging from the nature of the statoblasts, we have in this a new form; but unfortunately I have no material at present available.

It will be seen from the above remarks that there is plenty of room for investigation in connection with our Phylactolemata, and I am assured that a systematic search will prove very profitable, with a view to a further knowledge of the forms represented in our fresh waters, and the distribution of freshwater Polyzoa in general.

FREDERICELLA AUSTRALIENSIS, sp.n.

This species occurs abundantly in connection with our water-supply at Pott's Hill, and probably represents the only definitely known species other than the common European and North American species, *F. sultana* and *F. cunningtoni* from Lake Tanganyika. Several other species have been proposed but have been proved to be identical with *F. sultana*.

Davenport has given the following amended diagnosis for the genus:—"Stock branched in the form of antlers; more rarely massed with recumbent and elevated tubes; mostly brown or incrustated with algæ and grains of sand; rarely hyaline. Tubes cylindrical, the older ones mostly keeled. Without complete dissepiments. Apertures terminal at the broadened or bifid ends of tubes. Polypide very long and slender; tentacles arranged in a nearly circular corona. Few tentacles, not exceeding 24. Statoblasts dark brown, bean-shaped or elliptical, without float, and with smooth upper surface."

The above diagnosis has removed from the list of species, as synonyms of *F. sultana*, the following forms: *F. walcottii* Hyatt (1868); *F. pulcherrima* Hyatt (1868), and *F. regina* Leidy.

The only other species known are *F. du plessisi* Forel (1900), from Lake Geneva, the characters given for which form I cannot ascertain, and *F. cunningtoni*. As has been previously hinted in this account, the Australian species of *Fredericella* has been commonly regarded as being identical with *F. sultana*; and, as such, has been noted in Davenport's account in connection with the distribution of that North American and European species, the nature of the statoblast, when this character alone is considered, being such as to well and easily permit of the Australian form falling within the limits of the characters given for the genus *Fredericella* by Davenport, or, in other words, for the then only recognized species, *F. sultana*. It is certainly known that variation does take place in regard to the nature of the statoblasts, and this has been understood sufficiently well to enable the description of them to be "bean-shaped or elliptical"

in place of Allman's "bean-shaped." No statoblasts, however, which I have examined, resemble those shown by Allman, as representing these structures in *F. sultana*; and what variation has been noted has been very slight in any way approaching those of *F. sultana*. Variation in the shape of these structures can be seen in various directions in the statoblasts found in the same portion of a colony of *F. australiensis*, but rather towards an ovate appearance.

Diagnosis.—Young form closely adherent and branched; older colonies detached in younger parts; polypides seen only at the ends of filaments. Tubes not cylindrical, brown; tentacles 28-30, arranged in an elliptical corona; lophophore horseshoe-shaped in retracted condition. Not keeled, and devoid of dissepiments.

Statoblasts few in number, brown or black; broad elliptical, slightly ovate, or very slightly flattened on one side parallel to longer axis of the ellipse.

The chitin composing the ectocyst is about 0.003 mm. in thickness, and is quite clear when examined in section. It is always covered externally by a material of equal or greater thickness, consisting of a brownish matrix, abundantly scattered through which are the frustules of diatoms, etc. The stems of the colony appear in section as roughly triangular, in a great number of instances having the form of an equilateral triangle. At first, I was inclined to regard this as being due to lateral pressure in the process of sectioning the chitin, but the regularity of the occurrence and of the form itself, and contrast with the chitinous portion containing the polypide seems to disprove this. In this way we probably have another point of difference between this species and *F. sultana*, in which the tubes are cylindrical, the older ones keeled on one side. No traces of dissepiments (usually found, in an incomplete state, in *F. sultana*) can be seen in this species, near the commencement of branches or elsewhere.

The lophophore is not circular, like that of *F. sultana*, but elliptical. The tentacles, 28-30 in number, are towards the base united by a tentacular membrane, and cross-sections in this region measure 0.38 mm. in length, and 0.23 mm. in breadth. The

tentacles are about 1 mm. in length, and 0·01 mm. in diameter, these very slender structures rendering a graceful appearance to the animal. The lumen is about equal in diameter to the large cells composing the wall. These cells are square in shape, as seen in transverse section; and contain a large, deeply staining, centrally placed nucleus, about 5 or 6 of the cells encircling the lumen. They bear a strong resemblance to those lining the epistome. When the tentacles are retracted, it is seen in section that the lophophore is no longer elliptical in shape, but has been invaginated on the anal side so that two horns of it project on either side of the epistome; and this gives, in section, an appearance similar to that which exists among other members of the *Phylactolemata*, e.g., *Lophopus*, *Cristatella*, etc. This point has, perhaps, some little interest in this respect, inasmuch as *Fredericella* is unique among the members of the *Phylactolemata* in having a lophophore which is circular or elliptical, and not horse-shoe-shaped, and bridges over the gap in this direction between *Fredericella* and other genera, the folding, which one might on other grounds treat as being of no value, occurring in such a way that it agrees exactly as regards its detailed direction with the other genera. In counting the tentacles, use was made of transverse sections, so that no error could be made in this reckoning which is very difficult and unreliable if one used ordinary entire mounts of killed specimens. The epistome is a bluntly rounded tongue-like process, about 0·09 mm. in length. As seen in transverse section, it is oblongate-elliptical, with a slight concavity on the anal side, giving it a faint reniform contour. These sections measure 0·07 mm. in a line at right angles to the axis joining mouth and anus, and 0·016 mm. along that axis itself. The organ is thus seen to be flap-like in nature. Its wall consists of large columnar or squarish cells, with centrally situated nuclei, the limits of which, like the cells of the tentacles, which they much resemble, being readily made out. These cells constitute the wall in its entirety, no muscular layers, etc., being visible.

The œsophagus is about 0·3 mm. in length, and varies much in shape according to the condition of the polypide. In good

extension it is of an hourglass-shape; when partly extended it is an attenuated cylindrical tube; well withdrawn, it passes from a swollen cylindrical form into that of a cone, whose base is at the oral extremity, according as the retraction is partial or complete. It passes into the stomach, into which it is continued as a valve-like structure, which, although plainly visible in the perfectly extended polypide, is best shown under a certain amount of retraction. In transverse section it is circular, measuring, in the region between the mouth and anus, about 0.55 mm. in diameter; and in this protrusible portion of the polypide, constitutes the greater part of a section. It is lined by a layer of columnar cells with centrally situated nuclei, the height being about $2\frac{1}{2}$ -3 times the breadth. The cells are provided with long flagella in the part of the œsophagus lying between the mouth and the anus. Below this region no flagella are visible. Nearing the region of the stomach, the cells are much more compactly arranged, to pass into the lining layer of the stomach, and the nuclei are situated at the outer extremity of the cells. The œsophagus in this region has become more elliptical in shape.

The stomach and intestine are shown in figs. 2-4, in conditions of retraction and extension. The stomach is lined by cells, varying in shape in different regions, and with basally situated nuclei. At the oral end of the stomach, the lining cells are columnar; in the aboral region, the cells are clavate and columnar, and the wall has a sinuous contour. The cells lining the intestine are not so compactly arranged as in the stomach, and are cubical.

Nervous system.—A nerve-ganglion is present in close contact with the œsophagus on its anal side. It has a flattened reniform shape, and is inconspicuous in entire mounts. The cells composing it have a loose arrangement.

Reproductive organs.—No definite sexual organs were visible in the specimens examined.

Statoblasts.—Occurring in the same tube, one finds statoblasts quite different in shape and measurements. For instance, I have noted, in the same tube, statoblasts of which some are of a perfectly broad elliptical contour, some shading from this into an

ovate appearance, some more elongate and approaching an ellipse, but slightly flattened on one side parallel to the longer axis, and then again some of an elongate but ovate nature. These can be seen in figs.7-11.

In Allman's Monograph the statoblasts have a distinct bean-shaped appearance, but specimens obtained in Europe and North America evidently have shown that these structures may be elliptical in form. Considering the great number of specimens examined and the limits of variation as regards shape in the well known species, the Australian species is quite distinct.

The animals were killed in a good state of extension by adding a dilute solution of formalin, about 2%, gradually to the water, and the preservation was found to be good. For some reason the difficulty usually encountered in the cutting of chitinous structures was not met with in the sectioning of the organism, although no softening agent for chitin was used. The material was allowed to remain in molten hard paraffin (58°) over the bath for about one hour after passing through the various stages of embedding by the benzole method, and this probably facilitated the sectioning of the chitinous ectocyst. The method acted admirably for all the sections. Delafeld's hæmatoxylin was used for staining entire specimens, and was found to give much better detailed results than borax-carminé. The same stain was used for sections, with eosin as a counter stain.

I am indebted to Dr. Stokes, Medical Officer to the Board of Water Supply, for the following notes on the occurrence and habit of the species in connection with the water-supply reservoirs. He says—"It is found to grow luxuriously in the screening tank at Pott's Hill, near Rookwood, and also in the 72-inch main from the end of the lower canal to Pott's Hill. In the latter it is most abundant near the inlet into the pipe, forming dependent masses from the crown, as long as 18 inches. These resemble tangled locks of coarse brownish hair. I have not observed it in the open canal, although I am told it is found occasionally in such, beneath the shade of bridges and culverts. I have met with small pieces in water immediately leaving Prospect Reser-

voir. I assume that it will not flourish in such portions of the water-system where it is subjected to the direct influence of the sun's rays; and further, that its distribution in the pipe-line and screening tank is determined by its need for oxygen, which would be most abundant at the commencement of the pipe-line and where the water is again exposed to the air at the screening tank. I have no data to show the influence of pressure on the animal, but have found that it will live at a depth of 20-25 feet in the screening tank."

In its habits this species resembles *F. sultana*, which grows during the whole of the spring, summer, and autumn months, both in standing water and rivers, generally avoiding direct exposure to the daylight.

The following is a complete list of the forms recorded to date from Australasia :—

Victorella pavidia Saville Kent.—This genus is represented by one species, found by Whitelegge in brackish water on a species of *Nitella* in company with a tube-dwelling rotifer, *Æcistes* sp., in Cook's River. As far as I am aware, this form has not been recorded since.

Lophopus Lendenfeldi Ridley.—This species was named from specimens obtained by Whitelegge (and not by Lendenfeld) from the stems of aquatic plants in Parramatta Park. This species has not been found outside New South Wales. It differs from *L. crystallinus* chiefly in the absence of terminal angles of the statoblast, and the knobbed form of the inner end of the endocyst. The tentacles are also far longer than those of *L. crystallinus*.

Paludicella ehrenbergii Van Beneden.—Hamilton has recorded this species from Dunedin, New Zealand.

Plumatella Aplinii Macgillivray.—This species has been recorded from Victoria and New South Wales, and is undoubtedly a well founded form. I think that this form has also been found in New Zealand.

Plumatella princeps Kraepelin (*P. emarginata* Allman, 1844; *P. repens* Van Beneden, 1848 *P. diffusa* Leidy, 1851.)—This species occurs abundantly in Queensland, New South Wales, and

South Australia, and has also been recorded from New Zealand. This distribution would seem to indicate that it occurs throughout Australasia, and completes its cosmopolitan occurrence.

Plumatella sp.—Other undescribed species have been known for some time from New South Wales.

Alcyonella sp.—Whitelegge has recorded a species whose statoblasts resemble those of *Plumatella fruticosa* in shape, and are much narrower than those of *A. fungosa*.

We have now represented in Australia six genera (including *Alcyonella*), comprising six named species, and several unnamed forms; and of these, three are definitely known as endemic species—*Plumatella Aplinii*, *Lophopus Lendenfeldi*, and *Fredericella australiensis*.

Dendy has noted the occurrence of a species of *Fredericella* at Christchurch, New Zealand, which he identified as *F. sultana*, remarking on the occurrence of the same species in Australia. He noted, however, that his specimen differed from that figured by Allman for *F. sultana* "in being more slender and in the suppression (complete or partial?) of the ridge-like keel"; also that the epistome (whether due to contraction or not) was bluntly rounded at the apex. I am inclined to regard this form of epistome as being the natural condition of such in the extended condition, inasmuch as the same is found in the species described in this paper; and the New Zealand form agrees with this species in the characters given by Dendy as differentiated from *F. sultana*. Dendy has unfortunately not had the opportunity of examining the statoblasts, and has not made any remarks about dissepiments, both of which structures would be of much assistance in determining the New Zealand species. The number of tentacles is said to be "about twenty-two," and this character, evidently noted in the entire individual, is the only one which would prevent one, under our present knowledge of the species, from suggesting that the New Zealand species may be none other than *F. australiensis*.

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EXPLANATION OF PLATE XLVII.

Fredericella australiensis, sp.n.

- Fig. 1.— Portion of colony showing number and position of statoblasts in a relative fashion.
 Fig. 2.— Digestive system partly retracted: *æ.*, œsophagus.
 Fig. 3.— Same completely extended: *rc.*, intestine.
 Fig. 4.— Same completely retracted.
 Fig. 5.— Section through tentacle-region, showing shape of lophophore in retracted condition (diagrammatic).
 Fig. 6.— Same in extended condition: *ep.*, epistome; *æ.*, mouth.
 Figs. 7-11.— Statoblasts.
 Fig. 12.— Camera lucida drawing of a polypide. Only 24 tentacles are represented instead of 28.